SYSTEM AND METHOD OF PROVIDING VOICE AND DATA FEATURES IN A TIME DIVISION MULTIPLE ACCESS (TDMA) NETWORK

BACKGROUND OF THE INVENTION

Technical Field of the Invention

[0001]   This invention relates to telecommunication systems and, more particularly, to a system and method of providing voice and data features in a Time Division Multiple Access (TDMA) radio telecommunication network.

Description of Related Art

[0002]   In TDMA radio telecommunications networks, voice and data are handled in two different networks; a circuit-switched voice network is overlain by a packet-switched data network. For example, a Cellular Digital Packet Data (CDPD) network may overlay the voice network. If a mobile subscriber desires to utilize the voice network, he places his Mobile Station (MS) in voice mode, and the MS performs a standard registration procedure with the voice network. If the subscriber then desires

to send a data message, he places his MS in data mode. The MS sends a power-down registration message to the voice network and then performs an attach or registration procedure with the data network. The data message can

5 then be sent. However, since the MS has de-registered with the voice network, any incoming voice calls to the MS at that time are automatically diverted to voice mail, if available, or if voice mail is not available, an announcement is sent to the calling party stating that

10 the mobile subscriber is not available.

[0003] There is no interaction between the voice network and the data network. Even though the two networks are using the same frequency bands, they are using different channels. Therefore, the MS cannot

15 receive a voice call when it is in data mode, and cannot receive a data call when it is in voice mode. For example, if a mobile subscriber is conducting a voice call in the voice network, and an e-mail or any other data message is sent to him, the subscriber does not

20 receive the message or any indication that a data message is waiting. Thus, if there is an urgent call for the mobile subscriber, the calling party must know whether the MS is in data mode or voice mode, and the MS must be contacted in the mode in which it is currently operating.

25 [0004] It would be advantageous to have a system and method of providing voice and data features in TDMA

networks that enables the MS to be reached by a data message when the subscriber is on a voice call, and by a voice message when the subscriber is on a data call. It would also be advantageous for an indication to be provided to the subscriber that a call in the other mode is being received. The subscriber may then leave the mode he is in and take the incoming call. He can then go back and finish the ongoing call in the original mode. The present invention provides such a system and method.

SUMMARY OF THE INVENTION

[0005] In one aspect, the present invention is a method of setting up an incoming voice call from a calling party to a called mobile station (MS) that is operating in a data mode in a radio telecommunications network having a voice network portion and a data network overlay. Although the embodiment described herein illustrates the calling party as being a calling MS, it should be recognized that the calling party may also use a wireline phone or data terminal. The voice network portion includes a first Mobile Switching Center (MSC-1) serving the called MS, a Home Location Register (HLR) for the called MS, and a second MSC (MSC-2) serving the calling MS. The data network overlay includes a Mobile Data Immediate System (MDIS) serving the called MS and a gateway connecting the MDIS to an Internet Protocol (IP)

network. The method retains an active user record in the HLR for the called MS when the called MS switches from a voice mode to a data mode. The record indicates that the called MS is operating in the data mode. This is

5 followed by notifying the called MS that the incoming voice call is waiting, determining whether the called MS accepted the incoming voice call, and delivering the incoming voice call to the called MS upon determining that the called MS accepted the incoming voice call. The

10 method also prevents a call-setup timer in MSC-2 from expiring while notifying the called MS that the incoming voice call is waiting and determining whether the called MS accepted the incoming voice call.

[0006] In another aspect, the present invention is a

15 method of setting up an incoming data call from a calling MS to a called MS that is operating in a voice mode in a radio telecommunications network. The method includes the steps of receiving the incoming data call in an application server in the data network overlay, and

20 sending a data waiting message from the application server to a message center (MC) in the voice network. The MC then sends a Short Message Service (SMS) message containing a Data Waiting Indicator (DWI) to the called MS. This is followed by determining whether the called

25 MS accepted the incoming data call, and routing the

incoming data call to the called MS upon determining that the called MS accepted the incoming data call.

[0007]   In yet another aspect, the present invention is a system for setting up an incoming voice call from a calling MS to a called MS that is operating in a data mode in a radio telecommunications network having a voice network portion and a data network overlay. The system includes an indicator in a user record in the HLR for the called MS that indicates that the called MS is operating in the data mode, and a voice/data application server in the data network overlay that receives a notification from the HLR that the voice call is waiting, and sends the notification through the data network overlay to the called MS.   The system also includes a signaling mechanism in the HLR that receives a registration message from the called MS indicating that the called MS accepted the incoming voice call, and call processing logic in the HLR that prevents a call-setup timer in MSC-2 from expiring while the incoming voice call is being set up. The logic sends a first response message to MSC-2 instructing MSC-2 to suspend the timer until a second response message is received.   After the called MS accepts the voice call, a signaling mechanism in the HLR obtains a routing number for the called MS from MSC-1, and returns the routing number to MSC-2 in the second response message.

[0008]   In yet another aspect, the present invention is a system for setting up an incoming data call from a calling MS to a called MS that is operating in a voice mode in a radio telecommunications network having a voice network portion and a data network overlay. The system includes a message center (MC) that sends an SMS message containing a Data Waiting Indicator (DWI) to the called MS, and a signaling mechanism in MDIS-1 for receiving a registration message from the called MS indicating that the called MS accepted the incoming data call, and for sending the registration message to a voice/data application server in the data network. The voice/data application server in the data network overlay receives the incoming data call from MDIS-2 and sends a data waiting message to the MC. The application server also routes the incoming data call to the called MS after the registration message indicates that the called MS accepted the incoming data call.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009]   The invention will be better understood and its numerous objects and advantages will become more apparent to those skilled in the art by reference to the following drawings, in conjunction with the accompanying specification, in which:

[0010]   FIG. 1 (Prior Art) is a simplified block diagram of an existing TDMA network with a data network overlay;

[0011]   FIG. 2 is a simplified block diagram of the preferred embodiment of the system of the present invention;

[0012]   FIG. 3 is a signaling diagram illustrating the flow of messages between nodes in the radio telecommunications network when an MS is in data mode and a voice message is received, in accordance with the teachings of the present invention; and

[0013]   FIG. 4 is a signaling diagram illustrating the flow of messages between nodes in the radio telecommunications network when an MS is in voice mode and a data message is received, in accordance with the teachings of the present invention.

DETAILED DESCRIPTION OF EMBODIMENTS

[0014]   FIG. 1 is a simplified block diagram of an existing TDMA network 10 with a data network overlay 11. The voice network includes a first Mobile Switching Center (MSC-1) 12 that communicates through a first Base Station (BS-1) 13 with a called MS 14. The called MS has a Home Location Register (HLR) 15 that stores the called MS's user profile, status, and location information. A second MSC (MSC-2) 16 communicates through a second Base

Station (BS-2) 17 with a calling MS 18. When the called MS switches to voice mode, it registers with the HLR. Thereafter, when the calling MS places a voice call to the called MS, MSC-2 queries the HLR for location information. The HLR obtains a routing number from MSC-1 and returns the routing number to MSC-2. The voice call is then set up.

[0015] On top of the voice network 10 is the data network overlay 11 which may be, for example, a Cellular Digital Packet Data (CDPD) network. The data network may include a first Mobile Data Immediate System (MDIS-1) 21 which performs server functions for the called MS 14 in the data network. Like MSC-1 12, the MDIS-1 is also connected to BS-1 13, but is on a different control channel. MDIS-1 is on a data control channel while MSC-1 is on a voice control channel. A first Gateway (GW-1) 22 connects MDIS-1 to an Internet Protocol (IP) network 23.

[0016] In a similar manner, the calling MS 18 may be connected to the IP network 23. A second MDIS (MDIS-2) 24 is connected to BS-2 17 on a data control channel. A second Gateway (GW-2) 25 connects MDIS-2 to the IP network. Within the IP network, a data application 26 enables data to be transferred between the calling MS 18 and the called MS 14 when the two MSs are in data mode.

[0017] If the called MS 14 is operating in voice mode, and then switches to data mode, the called MS performs an

attach or registration procedure with MDIS-1 21 so that the called MS can send and receive data messages through the IP network. The called MS also sends a power-down registration message over the air interface to BS-1 13

5   and MSC-1 12. This message is sent as an ANSI-41 Registration Cancellation (REGCAN) message from MSC-1 to the HLR 15 to cancel the called MS's registration in the voice network. Thereafter, the user profile in the HLR indicates that the called MS is not registered (i.e., the

10 called MS is off). Thus, if the calling MS 18 then attempts to place a voice call to the called MS while it is in data mode, the call is immediately routed to voice mail, or the calling MS automatically receives a voice announcement that the subscriber is not available because

15 the called MS has canceled its registration with the HLR.
    [0018]   Likewise, if the called MS 14 is operating in data mode, and then switches to voice mode, the called MS cancels its registration with the data network and sends a Registration message to the HLR 15 to register in the

20 voice network. Thereafter, if the calling MS 18 attempts to place a data call to the called MS while it is in voice mode, the data network has no knowledge of the called MS, and the data call fails.
    [0019]   FIG. 2 is a simplified block diagram of the

25 preferred embodiment of the system of the present invention. FIG. 2 illustrates modifications to the voice

and data networks required to provide an indication to the called MS 14 that a voice call is waiting, after the called MS has switched from the voice mode to the data mode. In addition, the system provides an indication to

5   the called MS that a data call is waiting, when the called MS is operating in the voice mode. Although the embodiment described herein illustrates the calling party as being a calling MS, it should be recognized that the calling party may also use a wireline phone or data

10   terminal.

Scenario 1: MS in Data Mode Receives Voice Call

[0020]   When the called MS switches from the voice mode to the data mode, it sends an IS-136 power-down

15   registration message 1 to BS-1 13. The present invention modifies this message to include a Data Mode Indicator (DMI) that indicates that the called MS is switching to the data mode rather than shutting down. The power-down registration message with DMI is sent to MSC-1 12 which

20   adds a new field to the ANSI-41 Registration Cancellation (REGCAN) message 2 to include the DMI, and sends the modified REGCAN message to the HLR 15. The HLR puts the called MS in a new state called "data" in the user profile to indicate that the called MS is operating in

25   the data mode.

[0021]   FIG. 3 is a signaling diagram illustrating in more detail, the flow of messages between the nodes of the radio telecommunications network in the scenario in which an MS is in data mode and a voice message is received. Therefore, with reference to both FIG. 2 and FIG. 3, the remainder of the process will be described. When the calling MS 18 originates a voice call 32 toward the called MS 14, MSC-2 16, which is serving the calling MS, sends a Location Request (LOCREQ) Invoke message 33 to the HLR 15. The HLR first looks for the DMI in the subscriber profile. If no DMI was received with the REGCAN message 2, the HLR responds to the interrogating MSC-2 that the called MS is inactive. If a DMI was received, the HLR takes steps in accordance with the present invention to notify the called MS that there is an incoming voice call.

[0022]   While these steps are taken, other steps must be taken to prevent the voice call from timing out. In ANSI-41 call processing, a call-setup timer in MSC-2 16 may time out if the setup takes too long. Therefore, the timer in MSC-2 is suspended by sending a first LOCREQ Return Result message 39 from the HLR 15 to MSC-2 that includes a new indication that call setup may be delayed because the called MS 14 is in data mode. MSC-2 may then suspend the timer and optionally send an announcement 41 to the calling MS 18 that the call is being processed.

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MSC-2 then waits for a follow-up LOCREQ Return Result message 51 from the HLR with routing information.

[0023]   In order to notify the called MS that there is an incoming voice call, the HLR 15 sends a Call Notification (CALLNOT) Invoke message 35 with an indication that a voice call is waiting to a Voice/Data (V/D) application server 31 in the IP network. At 36 and 37, a CALLNOT Invoke message is sent from the V/D application server through GW-1 22 and MDIS-1 21 to the called MS 14 indicating that a voice call is waiting. The called subscriber may then choose to accept the voice call or reject it at 38.

[0024]   If the called subscriber rejects the voice call, the called MS sends a CALLNOT Return Result message 32-34 back through MDIS-1 21 and the V/D application server 31 to the HLR 15 with an indication that the voice call is rejected. The HLR then sends a follow-up LOCREQ Return Result message 51 to MSC-2 16 indicating that the voice call has been rejected. The call may then be routed to voice mail, or an announcement made to the calling MS that the called MS is not available. If the called subscriber ignores the voice call indication, a call setup timer in the V/D application server will expire. The V/D application server then notifies the HLR that the call has timed out, and the HLR sends the follow-up LOCREQ Return Result message to MSC-2

indicating that the call has not been accepted. The call may then be routed to voice mail, or an announcement made to the calling MS that the called MS is not available.

[0025]   If the called subscriber accepts the voice call at 38, he switches the called MS to voice mode. At 42 and 43, an indication of this switch is sent to the V/D application 31 in the CALLNOT Return Result message. If a data call was in progress, the V/D application server places the data call on hold. At 45 and 46, the called MS then re-registers with the HLR through MSC-1 12. The HLR recognizes from its database that it has sent the first LOCREQ Return Result message 39 to MSC-2 16 to suspend the voice call, and that the called MS has a voice call waiting. Normal call-setup procedures are then followed to obtain a routing number from MSC-1 and return the routing number to MSC-2 in the follow-up LOCREQ Return Result message 51. The voice call is then delivered to the called MS at 52.

[0026]   When the voice call is completed, the called subscriber may switch back to data mode to resume the data call. An attach or registration procedure is begun, and MDIS-1 21 recognizes that there is a call on hold for the called MS. The voice/data application is then notified that the called MS is back in data mode, and the data call is continued.

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[0027]   Referring now to FIG. 3, the signal flow depicted in FIG. 2 will be discussed in more detail. As noted above, when the called MS 14 switches from the voice mode to the data mode, the DMI is sent in the REGCAN message to the HLR 15, and the HLR puts the called MS in a new state called "data" in the user profile to indicate that the called MS is operating in the data mode. Thereafter, the calling MS 18 originates a voice call at 32 toward the called MS 14. MSC-2 16, which is serving the calling MS, sends a LOCREQ Invoke message 33 to the HLR 15. The HLR looks for the DMI in the user profile at 34 and determines that the called MS is in the data mode.

[0028]   In order to notify the called MS that there is an incoming voice call, the HLR 15 sends the CALLNOT Invoke message 35 to the V/D application server 31 in the IP network with an indication that a voice call is waiting. At 36 and 37, the CALLNOT message is routed from the V/D application server through MDIS-1 21 to the called MS 14. The called subscriber may then choose to accept the voice call or reject it at 38.

[0029]   While these steps are taken, other steps must be taken to prevent the voice call from timing out. Therefore, the timer in MSC-2 is suspended by sending a first LOCREQ Return Result message (LOCREQ R.R.-1) 39 from the HLR 15 to MSC-2 that indicates that call setup

may be delayed because the called MS 14 is in data mode. MSC-2 may then suspend the timer and send a notification or announcement 41 to the calling MS 18 that the call is being processed. MSC-2 then waits for a follow-up LOCREQ Return Result message from the HLR with routing information.

[0030] When the called subscriber accepts the voice call, he switches the called MS to voice mode. The called MS sends a CALLNOT Return Result message 42 to MDIS-1 21. At 43 and 44, the CALLNOT Return Result message is forwarded to the V/D application 31 and the HLR 15. If a data call was in progress, the V/D application server places the data call on hold. The called MS then sends a Registration Notification (REGNOT) message 45 to MSC-1 12 which forwards it to the HLR at 46. At 47, the HLR recognizes from its database that it has sent the first LOCREQ Return Result message to MSC-2 16 to suspend the voice call, and that the called MS has a voice call waiting. Therefore, the HLR sends a Routing Request (ROUTEREQ) Invoke message 48 to MSC-1 which returns a routing number in a ROUTEREQ Return Result message 49. The HLR then sends the routing number to MSC-2 in the follow-up LOCREQ Return Result message (LOCREQ R.R.-2) 51. The voice call is then delivered to the called MS at 52.

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Scenario 2: MS in Voice Mode Receives Data Call

[0031] FIG. 4 is a signaling diagram illustrating the flow of messages between nodes in the radio telecommunications network when an MS is in voice mode and a data message is received, in the preferred embodiment of the method of the present invention. For this scenario, an existing application such as Short Message Service (SMS) is utilized to send a Data Waiting Indicator (DWI) from a Message Center (MC) 27 to the called MS 14. The calling MS 18 originates a data call toward the called MS at 61. At 62, the data call is routed by MDIS-2 24 to the V/D application server 31. The V/D application server sends a Data Waiting message 63 to the MC indicating that the data call is waiting, and the MC forwards the message at 64 to the HLR 15. At 65, the HLR determines from the user profile that the called MS is in the voice mode. Therefore, at 66, the HLR sends a DWI to MSC-1 12 indicating that a data call for the called MS is waiting. At 67, the MSC-1 then sends an SMS message to the called MS with the DWI. The called subscriber may then choose to accept it or reject it.

[0032] If the called subscriber accepts the data call, the called MS 14 sends a power-down registration message 68 to MSC-1 12. The power-down registration message includes the Data Mode Indicator (DMI). At 69, MSC-1

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places any ongoing voice call on hold, and at 71, sends a REGCAN message with the DMI to the HLR 15. At 72, the HLR then sets the state of the called MS to "data" in the user profile.

[0033]   At 73, the called MS 14 then completes the switch to data mode, and registers with MDIS-1 21 at 74. At 75, the MDIS-1 forwards the registration to the V/D application server 31.   The V/D application server then connects the data call at 76, and at 77 the data call is delivered.

[0034]   When the data call is completed, the called subscriber may switch back to voice mode to resume the voice call. A Registration procedure is begun, and MSC-1 recognizes that there is a voice call on hold for the called MS. The MSC-1 then reconnects the voice call, and the voice call is continued.

[0035]   It is thus believed that the operation and construction of the present invention will be apparent from the foregoing description.   While the method, apparatus and system shown and described has been characterized as being preferred, it will be readily apparent that various changes and modifications could be made therein without departing from the scope of the invention as defined in the following claims.